Zero Retries issue 0009 2021-09-10

Advanced Amateur Radio - Data Communications; Space; Microwave… the fun stuff!
Nothing great has ever been accomplished without irrational exuberance. **Tom Evslin.**
Irrational exuberance is pretty much the business model of Zero Retries. **Steve Stroh N8GNJ**
The Universal Purpose of Ham Radio is to have fun messing around with radios. **Bob Witte K0NR**

Steve Stroh N8GNJ, Editor

Jack Stroh, Late Night Assistant Editor

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New Paradigm Network Amateur Radios - Part 3

This issue continues the discussion begun in Zero Retries 0007 - **New Paradigm Network Amateur Radios - Part 1 - Software Defined Receivers, Transceivers, and GNU Radio** and continued in Zero Retries 0008 - **New Paradigm Network Amateur Radios - Part 2**

Here are, what I see as additional "near term, kind-of-easy-to-implement" options for New Paradigm (High Speed) Network Amateur Radios. I list them below in order of (my perception of) feasibility:

The following were discussed in Zero Retries 0008 - New Paradigm Network Amateur Radios - Part 2:

- Use VARA FM with Existing Audio Interfaces and Radios.
- Use AREDN Radios to Create Mesh Networks (Microwave Frequencies).
- Use HamWAN and / or Part 15 Radios to Create Fixed-link Networks (Microwave Frequencies).
- Productize New Packet Radio into an Integrated Unit.
- Create / Modify Amateur Radio 2.4 GHz Power Amplifiers for 2.3 GHz AREDN Radios.
- Create a Driver Amplifier Compatible with Software Defined Transceivers.
- Create RAMA.

Continuing… Other Approaches to New Paradigm Network Amateur Radios

- Create / Modify RadioBerry for VHF / UHF.
- Create / Modify Hermes Lite 2 for VHF / UHF.
- Create an Equivalent of the SYMEK TX4RS Using 2021 Technology.
- Create an Equivalent of the Kantronics D4-10 Radio Using 2021 Technology.
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Create / Modify RadioBerry for VHF / UHF

Image courtesy of PA3GSB

RadioBerry is a remarkable (to me achievement) - an Open Source Software Defined Transceiver for HF implemented as a Raspberry Pi Hardware Attached on Top (HAT). There is also a companion power amplifier that provides 5 watts or 10 watts output (I've seen both power levels mentioned).

It's pure speculation on my part, but perhaps the RadioBerry design, being open source, could be adapted to a "RadioBerry V/U" for use on VHF and UHF.

Create / Modify Hermes Lite 2 for VHF / UHF

Image courtesy of Hermes Lite 2 Group Buy wiki page

In a comment on Zero Retries 0007, Jim Ancona N1ADJ wrote:

> In your discussion of HF radios you mentioned the Radioberry but not the Hermes Lite 2. The HL2 is a totally open source/open hardware network 5W HF transceiver with gigabit ethernet and lots of software support. So instead of a $3000 Flex 6000 plus transverter, maybe a $250 HL2 with a transverter would be a better option for an NPNAR, especially if someone with RF hardware chops would design a transverter add-on card to attach to the HL2. Steve KF7O, the designer of the HL2 has mentioned interest in supporting such a card.

N1ADJ - Thank you! So noted. Maybe Hermes Lite 2 would be a good platform for a NPNAR, and doubly encouraging that KF7O perhaps might develop transverters!

Then again, I could be overthinking this. Perhaps no *new* development is needed at all; perhaps a RadioBerry or Hermies Lite 2 as they exist now could simply be connected to an existing integrated HF to VHF / UHF transverter / power amplifier such as:

- Transverter Store
- Q5 Signal (formerly, Down East Microwave)
- Kuhne electronic

The goal of the "RadioBerry V/U" or RadioBerry combined with a transverter / power amplifier would be to have a Software Defined Radio on VHF and UHF frequencies at usable power levels.

Create an Equivalent of the SYMEK TX4RS Using 2021 Technology

Image courtesy of SYMEK GmbH

For a time, a very good high speed data radio specifically for Amateur Radio was available - the SYMEK TX4RS. It had a number of compelling features:

- Frequency agile within 430 - 440 MHz; can be changed remotely
- Power output 20 watts, can be changed remotely
- Fast TX/RX switching
- Wide modulator input, allowing data speeds faster than 9600 - up to 153600 bps

SYMEK discontinued the TX4RS in 2005. There were several issues unrelated to the radio itself. SYMEK was not well-known outside Germany and the EU and all but unknown in the US market. The early 2000s were giddy with excitement about the "new" Internet, and interest in Amateur Radio networking suffered a steep decline. If memory serves, the TX4RS was expensive at the time (though not priced unreasonably for the quality of the design). Although there was the expense of the radio, to make full use of it required a "Fast TNC", which SYMEK also offered as a product - the TNC3S.

In 2021, there is renewed interest in Amateur Radio Networking, especially at high speeds. Instead of TNCs and hardware modems, we now have Raspberry Pi running software such as Dire Wolf and high fidelity audio interfaces. For example, Dire Wolf has experimental support for radio data rates as high as 38400 bps, but there doesn't seem to have been much testing of that potential due to limitations of typical radios used for Amateur Radio. Dire Wolf is "just software" and open source, so if there was a radio like the TX4RS available, perhaps Dire Wolf can be enhanced to drive a TX4RS to higher speeds than 38400 such as what was possible with the SYMEK TNC3S and its 19200 bps, 38400 bps, 76800 bps, 153600 bps, 307200 bps, and 614400 bps modem boards.

Also in 2021 we have inexpensive, highly capable microcontrollers that can manage much of a internal operations of a radio versus dedicated chips and other components. Kudos to Symek for providing such a highly detailed User Manual for the TX4RS, including schematics and technical details, and continuing to make this manual available online. Unfortunately, the SYMEK website states "*Note: SYMEK GmbH has been liquidated in 2014. Sale of the products - as far as available - and service is still available*." Thus, recreating the TX4RS would have to be a new project with a new development team. Once a prototype has been developed, perhaps crowdfunding could be arranged, potentially through Crowd Supply) for a minimum order of, say, 100 units to justify a production run. Of course, this assumes that components can be found, given the global chip shortage.

Create an Equivalent of the Kantronics D4-10 Radio Using 2021 Technology

Photo from Steve Stroh N8GNJ collection

For a time, a reasonable high speed data radio specifically for Amateur Radio was available - the Kantronics D4-10. Kantronics discontinued the D4-10 so long ago that there is very little online record of the D4-10. The D4-10 had a number of compelling features:

- Price was reasonable - $350 (in the early 1990s)
- 10 watts power output
- Fast TX/RX switching
- Wide modulator input, allowing data speeds faster than 9600 - proven to 56000 bps

There were issues with the D4-10:

- Part of the D4-10's low price was that it used crystals instead of a frequency synthesizer. Thus you had to choose a frequency, and wait for your new crystals to arrive. Every D4-10 included crystals for 430.55 MHz installed.
- In that era, a "high speed" TNC was required to drive it, and those were expensive for 9600 bps and faster. Kantronics offered the companion Kantronics Data Engine (DE) with slots for two modem boards. The fastest modem board Kantronics offered was 19200, though it was possible to "hack" the DE to not use a modem board at all (see the link above) for high speed data.
- The D4-10 did not include crystal heaters for good frequency stability though changing temperatures, especially when used at facilities that weren't "room temperature" such as tower sites. Modifications were developed to improve frequency stability.

Electronically, the D4-10 was a simple radio. It seems that it would be "easy" to recreate its basic design using the radio technology of 2021, such as a

frequency synthesizer.

One of the most compelling reasons to consider recreating the D4-10 in 2021 is that as I discussed in Zero Retries 0007, in the article **Software Defined Receivers… *We Got!* The Low Hanging Fruit**, we already *have* good software defined receivers. Thus, perhaps all we need to recreate out of the D4-10 is the transmitter, further simplifying the design. For example, no need to fuss with a frequency synthesizer that can switch frequencies fast (such as would be needed for repeater operation). Nor is there need for fast transmit / receive mode switching - we simply don't need a receiver. Thus perhaps we can use the D4-10's basic design to create a new, very simple, inexpensive high speed data transmitter for Amateur Radio bands such as 222-225 MHz as well as 440-450 MHz.

For those that are interested in such a project, I have several Kantronics D4-10 radios in my archives, and I have the D4-10 manuals for them that I can make available.

Create an Equivalent of the Icom ID-1 Radio Using 2021 Technology

Image courtesy of Icom America

The Icom ID-1 was developed in the early 2000s. The ID-1 included Icom's D-Star Digital Data (DD) mode - data rate of 128 kbps using a 100 kHz channel on the 1240-1300 MHz band. The ID-1 had a transmit power output of 10 watts. Icom also offered a "DD mode" repeater module (also required a D-Star Repeater Controller), but in truth, it wasn't really a repeater, but was more of a digipeater (didn't transmit and receive full duplex). It was a reasonable effort for the time, and the capability of Icom at the time. The ID-1 was hobbled by poor networking implementation, and very high price. Although Icom has recently discontinued the ID-1, the DD mode was continued in the Icom IC-9700 radio. There are occasional hints and rumors that Icom will release a new ID-1 / DD / 1240 - 1300 MHz repeater module.

The D-Star DD mode - ID-1 user radios and ID-1 repeaters on 1240 - 1300 MHz, are still in use in a number of areas. I put out a query to the Groups.io D-STAR23cm mailing list and feedback was that there are active D-Star DD 1240-1300 MHz "repeaters" in these areas:

- Atlanta, GA
- Dallas, TX
- Detroit, MI
- Huntsville, AL
- Las Vegas, NV
- Minneapolis / St. Paul, MN
- New Mexico (cities unstated)
- Orlando, FL
- Vancouver, BC
- Walburg (Georgetown / Austin), TX
- Washington, DC
- Wausau, WI

(See the list for details on these systems.)

The networking capability of the ID-1 and the ID-1 repeater was… less than optimum, even for the early 2000s. That's perhaps understandable given that Icom is a radio company, not a networking company. We can do much better in 2021, even embedding something as "simple" as a $35 Raspberry Pi 3 (or equivalent Raspberry Pi Compute Module). The Vancouver, BC D-Star DD users implemented some interesting ideas on how to build a true ID-1 / DD repeater.

In researching this, I was reminded by several correspondents that the D-Star specification is open… albeit mostly written in Japanese. That's not the same as "closed" or "proprietary to Icom". It just means that the details of implementation are a bit harder to discern than in a specification that was developed in English. If this effort were to get some momentum, there are many Japanese Amateur Radio Operators that are conversant in English. I've met a number of them at Digital Communications Conferences and have had delightful conversations with them. One source of contact is the Packet Radio User's Group (PRUG).

Using 2021 technology, it seems reasonable that an open source equivalent of the ID-1 / DD mode on 1240-1300 MHz could be developed. One primary cost reduction that could be made would be to not include a voice subsystem (no codec, no microphone, no speaker) or a front panel unit. With ample compute power, perhaps faster data speeds could be achieved (similar to New Packet Radio, which uses the same 100 kHz channel size to achieve 500 kbps) and incorporate forward error correction… and of course, much better networking.

Create a 1240-1300 MHz Radio Based on an 802.11 Chipset

I'm in awe of what the developers of Amateur Radio Emergency Data Network (AREDN) have accomplished in repurposing Part 15 / Wireless Internet Service Provider / consumer Wi-Fi radios into auto-configuring mesh network units operating on spectrum near 2.4 GHz that's exclusive to Amateur Radio (2.937 - 2.407 GHz). Especially given that:

- The radios are low-powered, even the Wireless Internet Service Provider units because they're operating under Part 15 (license exempt) rules.
- There is only 10 MHz of spectrum available; a 10 MHz channel provides reasonably fast data communications, splitting it into two 5 MHz channels isn't quite as fast, but still reasonable.
- 2.3 GHz is problematic for long range links, especially at Part 15 power levels.

Perhaps we could create a new radio for AREDN (and other) use with the following features:

- Uses a commodity Wi-Fi chipset that allows use of 5 MHz and 10 MHz channels
- Chipset is compatible with OpenWRT firmware
- Ample RAM and flash memory for software, storage, safe remote flashing (falls back to previous image)
- Operates from 12 volts
- Incorporates a bidirectional 2.4 GHz to 1240 - 1300 MHz transverter
- Incorporates a power amplifier for at least 5 watts, preferably 10 watts
- External Type N antenna connector
- Diversity reception if chipset permits it (optional, could add significant expense)
- Small enough, temperature stable enough to install on within a few feet of the antenna on a pole or tower (only a few feet of feedline is required)

I suspect such a radio would quickly achieve wide adoption.

Create a Frequency Hopping Spread Spectrum Radio Using 2021 Technology

Roughly two decades ago, BreezeCOM debuted its BreezeNET wireless network system. BreezeNET was notable because it was a Frequency Hopping Spread Spectrum (FHSS) system operating in the 2.4 GHz band, which even then was becoming "polluted" for outdoor use by Wireless ISPs hacking up 802.11 and all other manner of wireless systems including wireless television cameras. BreezeNET didn't care - it used a 1 MHz channel to achieve 3 Mbps. BreezeNET "hopped" its 1 MHz channel pseudo randomly across all 83 MHz of the 2.40 - 2.4835 GHz band to make its signal a "moving target". If a "hop" encountered interference that prevented a successful data transfer, there was an automatic retry mechnanism (ARQ). BreezeNET was a successful product, only eclipsed when customers began demanding more than 3 Mbps speeds.

There were other such FHSS systems for the 2.4 GHz band, including one that was derived from German military technology. FHSS lives on in the 2.4 GHz band, in every mobile phone in the form of Bluetooth, which is how Bluetooth can coexist with Wi-Fi in the 2.4 GHz band. The 902-928 MHz band has become nearly fully populated with automatic meter reading systems for natural gas, water, and power. Despite that "pollution", companies like FreeWave Technologies continue to sell FHSS systems that operate reliably in the 902-928 MHz.

In the mid 1990s, TAPR attempted to jump start the idea of Spread Spectrum in Amateur Radio by obtaining a Special Temporary Authority (STA) from the FCC, and tried to develop a Spread Spectrum radio for Amateur Radio operations. I was a "mostly passive" participant in the STA, though I did file a 4-page Reply Comment on RM-8737. My sole participation in spread spectrum operation was that I was a user of Metricom Ricochet, a Frequency Hopping Spread Spectrum radio system operating in the 902-928 MHz band. It worked great, and the data rates were reasonable (for the time).

What I most admired about TAPR's efforts at the time was that they tried… *mightily*… and in all the *right* ways, including engaging a capable communications law firm in Washington DC (at no small expense) and for all the right *reasons* to achieve some reasonable rules updates that would permit meaningful Spread Spectrum operations. In the end, that effort largely failed. There were some updates, but the meaningful changes were gutted by lack of support, and outright opposition, by the ARRL. As a result of my research (reading, discussing with others) I came to believe, and still do, that Frequency Hopping Spread Spectrum (FHSS) radio would work well in Amateur Radio bands above 50 MHz with no noticeable degradation to other modes of Amateur Radio operation on those bands. The key to FHSS is a minimal dwell time on any channel - on the order of 100 mS. The radio switches to a new channel, sends and receives its data, and then switches to another channel in a pseudo random pattern. That's hardly any time at all with less sophisticated modes such as FM or packet radio.

Now that we have broad band radios that are capable of FHSS, I think it's worth another try, with prototype (or software defined) hardware, and obtaining yet another Special Temporary Authority. Or not… I very much doubt that a well-designed FHSS system operating in 420-450 MHz would even be noticeable by any but the most technically sophisticated Amateur Radio Operators operating specialized monitoring equipment.

Like with the Kantronics D4-10 radios, for those that are interested in a FHSS project, I have several Metricom Richochet radios in my archives that operate FHSS on 902-928 MHz. Although Ricochet was a network system (and the network is long, long gone), the radios I have included a peer-to-peer mode, and thus potentially could be useful for reference.

Request To Send

This is a reminder that the 2021 ***(40th!)*** ARRL and TAPR Digital Communications Conference (DCC) will occur next Friday September 17, and Saturday September 18. As with the 2020 DCC, this year's DCC will be virtual. I, and coauthor Andy Sayler KF7VOL have submitted a paper for the Proceedings

called Multipurpose Remote Nodes.

This issue concludes the discussion of hardware aspects of New Paradigm Network Amateur Radios. It will be interesting to see if any of these ideas resonate (yes, radio pun intended) with someone or a group that has the ability to make them a reality. If I can help, please let me know.

Closing The Channel

A commenter in Reddit pointed out that I should disclaim that the views I express in about Amateur Radio in Zero Retries are mostly about Amateur Radio in the US. That comment is correct, thus consider it disclaimed that Zero Retries has a US-centric perspective of Amateur Radio. I do my best to think of "rest of world" Amateur Radio in my writing, but I'm not there in other parts of the world, so if I say something blatantly inaccurate, please call me out.

If you're enjoying Zero Retries, please tell your friends and co-conspirators. Feedback is easy if you're reading Zero Retries in email - just hit Reply and I'll get your email. Or you can go to the web version of any Zero Retries issue, scroll to the bottom, and post a comment on the web version of a Zero Retries issue. I'm especially interested in content ideas about things that you'd like to see discussed in Zero Retries. If you know of "Zero Retries Interesting" projects, groups, activities, etc. please let me know. I do reply to every Zero Retries email I receive.

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All previous issues of Zero Retries are available without restriction (no paywall). For some background on Zero Retries, Issue 0000 was The Introduction Issue.

Thanks for reading!
Steve Stroh N8GNJ
Bellingham, Washington, USA
2021-09-10
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Below is a much more complete "footer" that has evolved over 30+ issues of ZR.

Join the *Fun* on Amateur Radio

If you're not yet licensed as an Amateur Radio Operator, and would like to join the fun by *literally having a license to experiment with radio technology*, here are some pointers:

- **Ham Radio for Dummies** by Ward Silver N0AX is a great overview of Amateur Radio. N0AX is a gifted writer and HRFD is now in its 4th edition.
- My two favorite **YouTube** channels for a good overview of Amateur Radio are AmateurLogic.TV. and Ham Nation (part of Ham Radio Crash Course). These folks just seem to have so much fun!
- Radio Amateur Training Planning and Activities Committee (**RATPAC**) offers weekly presentations on general Amateur Radio topics (Wednesdays) and emergency communications in Amateur Radio (Thursdays).
- Dan Romanchik KB6NU offers a free **No-Nonsense Study Guide** for the Technician test (PDF).
- HamExam.org Amateur Radio Practice Exams offers good **Flash Card and Practice Exams**.
- When you're ready to take an **Amateur Radio examination** (Tech, General, or Extra), W1MX - The MIT Amateur Radio Society offers remote exams, free for students and youngsters. *There are apparently many other remote exam options*.

Bonus - with an Amateur Radio license, you'll be more attractive on dates 😀

Closing the Channel

- In its mission to grow Amateur Radio and make it more relevant to society in the 2020s and beyond, Zero Retries is published via email and web, and is available to anyone at no cost. Zero Retries is proud *not to participate* in the Amateur Radio Publishing Industrial Complex!
- My ongoing Thanks to Tina Stroh KD7WSF for, well, *everything* and Bill Vodall W7NWP as *Zero Retries Instigator in Chief*.
- My ongoing Thanks to pseudostaffers Dan Romanchik KB6NU and Jeff Davis KE9V for continuing to spot, and write about "Zero Retries Interesting" type items, on their respective blogs, from Amateur Radio and beyond, that I don't spot on my own.
- Southgate Amateur Radio News consistently surfaces "Zero Retries Interesting" stories.
- The Substack email publishing platform makes Zero Retries possible. I recommend it for publishing newsletters.

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More bits from Steve Stroh N8GNJ:

- SuperPacket blog - *Discussing new generations of Amateur Radio Data Communications - beyond Packet Radio (a precursor to Zero Retries)*
- N8GNJ blog - *Amateur Radio Station N8GNJ and the mad science experiments at N8GNJ Labs - Bellingham, Washington, USA*

Thanks for reading!
Steve Stroh N8GNJ (He / Him)
These bits were handcrafted in beautiful Bellingham, Washington, USA

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Update - Minor formatting changes were made 2023-04-07; no content was changed.